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Earth Surface Dynamics Discussions

Interactive comment on "Topographical changes caused by moderate and small floods in a gravelly ephemeral river – 2D morphodynamic simulation approach" *by* Eliisa Lotsari et al.

Anonymous Referee #1

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This manuscript describes the calibration of a depth-averaged Delft3D morphodynamic model for an ephemeral gravel bed river. Subsequent analysis of model predictions, for a small and moderate flood, examine the relative importance of rising and falling hydrograph limbs for erosion and deposition. Pre- and post-event topographic surveys, acquired using mobile terrestrial laser scanning and RTK-GNSS, are used to provide topographic data to provide boundary conditions and evaluate model performance. The use of a spatially-distributed morphodynamic model to gain insight into ephemeral river processes is novel, promising and interesting. I think the manuscript has the potential to make a significant contribution. However, I have some major concerns:

1) The morphological model calibration exercise is not especially novel (see e.g. Schuurman et al., 2013; Williams et al., 2016b). However, the application and analysis of the morphodynamics of a braided ephemeral river is, in my opinion, where this manuscript has the greatest potential for impact. I would recommend that the paper is re-focused (in the introduction, results, discussion, conclusions) to emphasise the geomorphological findings that arise from the morphodynamic model results (as analysed in section 5.2 which considers flood sequencing, rising/falling hydrograph, diagonal bar formation, hysteresis and discharge thresholds). This would distinguish this paper from other published work that has discussed and explained the relative importance of representing different processes in morphodynamic models of gravel-bed rivers.

2) The morphological model description does not mention bank erosion. Is bank erosion represented in the model? Bank erosion has been identified as an important process in perennial gravel-bed rivers (Wheaton et al., 2013). Although existing, simplified bank erosion algorithms (e.g. repose schema in Delft3D) may be inadequate in representing natural rates of lateral adjustment (Stecca et al., 2017) there is a need to justify the incorporation (or not) of lateral adjustment in the model.

3) The study area description describes how a lobe is forming in the model domain? Is this a result of enhanced sediment supply from upstream? Is an equilibrium sediment supply boundary at the upstream end of the model a suitable assumption?

4) Has any analysis of uncertainty in topographic been incorporated into the volumetric calculations of erosion and deposition (see e.g. Wheaton et al., 2010). Although the mobile laser scanning error is quotes as 0.034 m for the March 2012 survey (Table 1) this may still be significant depending upon the magnitude of changes, particularly deposition. In addition, it would be useful to have figures showing patterns of observed and predicted morphological change. I think these would be more useful for evaluating model performance than the maps of observed and post-event predicted topography (within section 4.2).

5) Spatially variable roughness is used for some simulations (description P11 L15). For morphodynamic simulations, is roughness recalculated from the surface grain size distribution or is spatial variation fixed a priori?

6) The modelling undertaken is calibration rather than a sensitivity analysis (P13 L2).

7) The presentation of methods and results on the MPM bedload transport formula. On P14 it is stated that this is not integrated into the Delft3D code (which it is, see Williams et al., 2016b) yet this is contradicted on P19 where MPM results are discussed.

8) I am not convinced that the threshold of 30 cumecs is widely applicable (conclusion 7). What about the influence of other river styles, sediment sizes, vegetation interactions)?

9) Some sentences require sharpening / clearer expression (some are identified below). Check methods and results are consistently written in the past tense.

10) Data availability statement: since this is an open access journal I would expect the observed topography and model input files (as a minimum for the calibrated model runs for the small and moderate events) to be packaged up and available for download (perhaps with a dataset doi – see e.g. re3data.org to search suitable repositories). This would promote the "reproducibility" of the research and enable readers to re-run the models, if they were interested in analysing aspects of the results that are not presented in this paper.

OTHER COMMENTS Title: Does changes need to be plural? "Gravelly" or "gravel bed" (also consider elsewhere) Delft2D: Delft3D is the name of the software but the simulations are executed in shallow water mode. Use "depth-averaged Delft3D" or similar phrasing rather than Delft2D.

P1 L15: Change performed to caused.

P1 L18: We pursue is an odd phrase in this context.

P1 L20-22: This is the key research question – see my comment 1 above about emphasising this throughout the manuscript.

P1 L28-31: Is there sufficient evidence from the two simulated events to extrapolate a conclusion about flood sequencing?

P2 L19: Yes, dynamics during high flows are difficult to measure but there are some attempts to do this e.g. Williams et al., 2015.

P2 L23: Williams et al. citation should be 2016b not 2013

P2 L28-29: How did the Hooke et al. (2005) model perform? Be more critical / analytical in the literature review examination (and this also goes for other parts of the introduction e.g. P2 L31 – why do the uncertainties arise?)

P2 L32: References to the use of repeat surveys for morphodynamic modelling could be stated e.g. Lotsari et al., 2013; Williams et al., 2016a

P3 L2: Broader references are needed here e.g. Milan et al., 2009

P3 L1: Within this paragraph you could emphasize more strongly that since ephemeral rivers can be surveyed whilst the river bed is dry, the topographic survey is characterised by lower errors because wet areas are usually associated with greater survey uncertainty.

P3 L15: I suggest emphasising the geomorphological research questions rather than the calibration exercise (see comment 1 above).

P4 L17: Where is the evidence that these sized grains were moved?

P5 L8: Are morphological and topographic both needed?

P5 L15: Clarify whether the grain size distributions were spatially distributed.

P6 L12: Clarify in the text whether the re-scaling with linear.

Figure 3 legend: More commentary is needed. Abbreviations need to be stated. A

location map would be useful.

P8 L2: Sentence 2 – The three datasets need to be introduced before this sentence.

P8 L18-19: Sentence not clear

P8 L25: Typo MSL

P9 L16-20: Sentences not clear.

P9 L28: What guidance was used to sample a 10 cm layer?

P9 L30: Is this difference for the upper or sub layer?

P10: How many size fractions were used in the model?

P10 L11: It would be useful to refer to a map here.

P11 L1: Insert “solving” after “for”.

P11 L5: This event has previously been referred to as March 2013 rather than 6.3.2013. Be consistent

P12 L12: Quantify “sufficiently well”

Table 6: Separate volumes and

Fig 4 / 5: Be consistent in use of “After” in figures (top left corner) but not in other sub-figures.

P20 top paragraph: The morphological change description here is interesting and I think the results / discussion would benefit from more analysis of this style. Section 5.1: This discussion needs to be more closely integrated into the discussion in other, similar Delft3D (or other graded sediment morphological model) calibration findings.

P25 L11: “Unique” – from sample of 2?

P25 L31: “differs” – explain why

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